

Properties and Classifications of Matter

PS-3 The student will demonstrate an understanding of various properties and classifications of matter.

PS-3.6 Compare the properties of the four states of matter—solid, liquid, gas, and plasma—in terms of the arrangement and movement of particles.

Taxonomy Level: 2.6-B Understand Conceptual Knowledge

Key Concepts:

Kinetic theory

States of Matter: solid, liquid, gas, plasma

Previous/Future knowledge: In 5th grade (5-4.2) students compared the physical properties of the states of matter (including volume, shape, and the movement and spacing of particles). This concept has not been revisited since that time.

Although the 5th grade and Physical Science indicators appear to be similar, Physical Science students develop a mental image of atoms and molecules and are conceptually prepared for a deeper understanding of the phases of matter in terms of the kinetic theory.

It is essential for students to

- Understand the kinetic theory; (see PS-3.5)
- Understand the characteristics of solids, liquids, gases, and plasma in terms of the kinetic theory.

<i>Solids</i>	<ul style="list-style-type: none">• The particles of solids are closely packed together because there is an attractive force holding them together• The particles of solids are constantly vibrating, but they do not readily slip past one another.• Because the particles vibrate in place and do not readily slip past one another, a solid has a definite shape.
<i>Liquids</i>	<ul style="list-style-type: none">• The particles of liquids are in contact with each other because there is an attractive force holding them together.• The particles of liquids have enough energy to partially overcome the attractive force of the surrounding particles. Liquid particles can slip past surrounding particles and slide over one another. Because the particles slip past one another, a liquid does not have a definite shape and so takes the shape of the container. A sample of a liquid can be poured.
<i>Gases</i>	<ul style="list-style-type: none">• The particles of gases are not in contact with each other because they have enough energy to completely overcome the attractive force between or among the particles.• The particles of gases are moving randomly, in straight lines until they bump into other particles or into the wall of the container. When a particle hits another particle or the container, it bounces off and continues to move.• Because gas particles move independently, the particles move throughout the entire container. The forces between the particles are not strong enough to prevent the particles from spreading to fill the container in which the gas is located.

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<i>Plasma</i>	<ul style="list-style-type: none">• Plasma is matter consisting of positively and negatively charged particles.• A substance is converted to the plasma phase at very high temperatures, such as those in stars (such as the sun). High temperature means that the particles of a substance are moving at high speeds. At these speeds, collisions between particles result in electrons being stripped from atoms.• Plasma is the most common state of matter in the universe, found not only in stars, but also in lightning bolts, neon and fluorescent light tubes and auroras.
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It is not essential for students to

- Differentiate crystalline from amorphous solids (Addressed in subsequent chemistry classes);
- Understand various crystalline structures or types of packing (Addressed in subsequent chemistry classes);
- Understand various intermolecular forces (Addressed in subsequent chemistry classes);
- Convert Celsius temperature to Fahrenheit.

Misconceptions: Students often believe that at a given temperature the particles of all liquid substances are moving faster than the particles of all solid substances, and that the particles of gaseous particles are moving fastest of all. It is important that students understand that at a given temperature, all matter has the same average kinetic energy and that in each sample there are particles moving at all different rates of speed. As temperature increases, more particles move fast, fewer particles move slowly. The reason that various types of matter are in various phases at a given temperature is primarily due to the variation in the strength of the forces between the particles of various substances. Materials change phase when they absorb enough energy to break/overcome the attractions between the particles of which they are composed.

Assessment Guidelines:

The objective of this indicator is to compare the properties of the phases of matter with regard to the arrangement and motion of particles, therefore, the primary focus of assessment should be to detect similarities and differences between the phases of matter showing understanding of the reasons for particle arrangement and movement in terms of the kinetic theory.

In addition to compare, assessments may require that students

- Illustrate with words, pictures, or diagrams particle motion and arrangement in a solid, liquid, gas, or plasma;
- Classify a substance as a solid, liquid, gas, or plasma based on a description of the particle arrangement and motion;
- Summarize the characteristics of the particle motion in solids, liquids, gas, and plasma;
- Recognize the four states of matter by their characteristics.